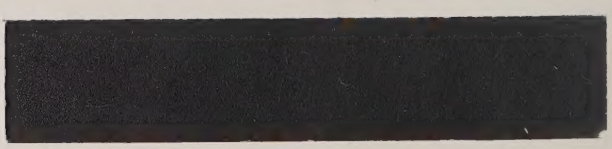
Farnell

DIGITAL MULTIMETER DM141

INSTRUCTION BOOK



INSTRUCTION BOOK FOR

DIGITAL MULTIMETER DM141

FARNELL INSTRUMENTS LIMITED, SANDBECK WAY, WETHERBY LS22 4DH, YORKSHIRE

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SCHEDULE OF EQUIPMENT

The instrument has been carefully packed to prevent damage in transit. When removing the unit from the packing box, be sure that all parts and accessories are removed from the packing material.

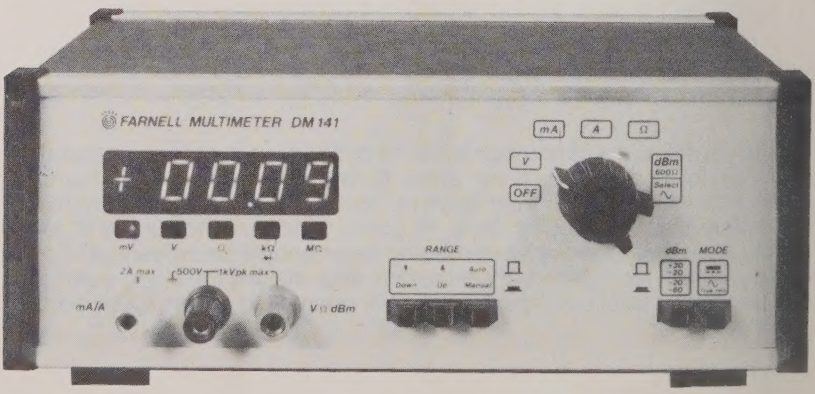
The complete equipment comprises:–

a) 1 off DM141 as ordered
b) 1 off pair test leads (red and black) 4mm terminated
c) 1 off pair crocodile clips (with 4mm receptical)
d) 1 off red test prod (with 4mm receptical)
e) 1 off instruction book
f) Any additional accessories specified on order

Note:- In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Farnell Instruments Ltd., within three days of receipt of the goods, followed by a complete claim within five days. All goods which are the subject of any claim for damage in transit or missing items should be preserved intact as delivered, for a period of seven days after making the claim, pending inspection instructions from Farnell Instruments Ltd., or an agent of this Company.

INTRODUCTION

The DM141 is a 4½ digit six function automatic digital multimeter which in 22 ranges measures 10 microvolts to 1000 volts d.c., 10 microvolts to 750 volts true r.m.s. a.c., 1μA to 2 amps d.c., 1μA to 2A true r.m.s. a.c. and +30 to −60 true r.m.s. dBs. A diode testing facility is also provided.
All functions are selected by a single knob and with the exception of current measurements, input is via two terminals. Polarity and zero are automatic so there is no need for lead switching or manual zeroing.
Ranging is automatically determined and provides maximum resolution for the input level. The unit changes UP range at 19999 and DOWN range at 1800. A range select facility is also provided enabling any range to be selected at will, so that measurements can be taken around full scale of 19999 without constant changes in resolution. It also enables the full scale length to be increased to 28500 counts, although the 2 is not displayed and the other 4 digits flash indicating overrange.
Readings are shown on red LED displays of 0.43" (10.92mm) character height, and visual indication of function, units being measured, polarity (where appropriate) and position of decimal point is provided. These facilities eliminate ambiguities and scaling factors.
All a.c. functions and dBs are true r.m.s. sensing between 40Hz and 20kHz. The unit directly computes the true r.m.s. value of any complex a.c. waveform of crest factor up to 5.
Input protection against most accidental misuse is provided on all functions, comprising electronic protection on volts, ohms and dBs and a fuse on the current ranges. Transient protection is also incorporated on volts, ohms and dBs up to 2.5kV.
The instrument is normally factory preset to operate from an a.c. mains supply of 215 to 255 volts, 50Hz but can be supplied or adjusted to operate from 110 to 125 volts, 50Hz. Alternative mains frequencies can be accommodated to special order.



SPECIFICATION

DC VOLTS

ACCURACY

RANGE (fs)	RESOLUTION	ACCURACY (1 YR @ 23°C ± 5°C)
199.99mV	10µV	±(0.03%rdg + 6d)
1.9999V	100µV	±(0.02%rdg + 2d)
19.999V	1mV	±(0.03%rdg + 2d)
199.99V	10mV	±(0.03%rdg + 2d)
1000.0V	100mV	±(0.03%rdg + 2d)

RANGING	Automatic or manual HOLD – UP – DOWN
MAX. INPUT VOLTAGE	1000V d.c. and peak a.c. Transient protection to 2.5kV
TEMPERATURE COEFFICIENT	25ppm C^{-1}
INPUT RESISTANCE	10MΩ
NMRR	60dB
CMRR	100dB at 50Hz (1kΩsource impedance unbalance)
INPUT TYPE	Floating, 500V max. with respect to supply earth

DC CURRENT

ACCURACY

RANGE (fs)	RESOLUTION	ACCURACY (1 YR @ 23°C ± 5°C)
19.999mA	1µA	±(0.1%rdg + 4d)
1.9999A	100µA	±(0.25%rdg + 4d)

RANGING	Manual selection
MAX. INPUT	2A Fuse protected
TEMPERATURE COEFFICIENT	19.999mA 10ppm $°C^{-1}$ + d.c. volts temp. coefficient
	1.9999A 50ppm $°C^{-1}$ + d.c. volts temp. coefficient
VOLTS DROP	200mV at full scale
INPUT TYPE	Floating, 500V max. with respect to supply earth

A.C. VOLTS

(True r.m.s. responding)

ACCURACY

	RANGE (fs)	RESOLUTION	ACCURACY @ 23°C ± 5°C 1 YR 45Hz to 1kHz	1kHz to 20kHz
>20% range	199.99mV	10µV	±(0.25%rdg + 0.25%fs)	±(0.5%rdg + 0.5%fs)
	1.9999V	100µV	±(0.25%rdg + 0.25%fs)	±(0.5%rdg + 0.5%fs)
	19.99V	1mV	±(0.25%rdg + 0.25%fs)	±(0.5%rdg + 0.5%fs)
	199.99V	10mV	±(0.5%rdg + 0.5%fs)	±(0.5%rdg + 0.5%fs)
	550V	100mV	±(0.5%rdg + 0.5%fs)	-
	750V	100mV	±(0.5%rdg + 0.5%fs) 45-100Hz only	-

RANGING	Automatic or manual HOLD – UP – DOWN
MAX. INPUT VOLTAGE	750V rms 1000V peak 100Hz
	Transient protection to 2.5kV
CREST FACTOR	5:1 up to 10,000 counts
	2.5:1 up to 20,000 counts
TEMPERATURE COEFFICIENT	(0.02%rdg + 0.02%fs) $°C^{-1}$ 45Hz to 1kHz
	(0.1%rdg + 0.02%fs) $°C^{-1}$ 1kHz to 20kHz
INPUT IMPEDANCE	10MΩ shunted by 200pf
INPUT TYPE	Floating, 500V max. with respect to supply earth

A.C. CURRENT

ACCURACY

	RANGE (fs)	RESOLUTION	ACCURACY 1 YR @ 23°C ± 5°C 45Hz to 1kHz	1kHz to 20kHz
>20% range	19.999mA	1µA	±(0.35%rdg +.25%fs)	±(1%rdg + .5%fs)
	1.9999A	100µA	±(0.5%rdg +.25%fs)	±(1%rdg +.5%fs)

RANGING	Manual selection
MAX INPUT	2A Fuse protected
TEMPERATURE COEFFICIENT	19.999mA 10ppm $^{\circ}C^{-1}$ + a.c. volts temperature coefficient
	1.9999A 50ppm $^{\circ}C^{-1}$ + a.c. volts temperature coefficient
VOLTS DROP	200mV at full scale
INPUT TYPE	Floating, 500V max. with respect to supply earth

dBm (TRUE RMS RESPONDING)

ACCURACY

RANGE (dBm)	LIMITS	ACCURACY (dBm) 1 YR @ 23°C ± 5°C 45Hz to 1kHz	1kHz to 20kHz
	+30 to +20	1.0	1
+30 to −20	+20 to −10	0.5	1
	−10 to −20	0.5	2
−20 to −60	−20 to −50	0.5	1
	−50 to −60	1.0	2

RESOLUTION	.01dBm (both ranges)
RANGES	Manually selected
MAX. INPUT VOLTAGE	750V peak 100Hz or 550V @ 1kHz (overload)
TEMPERATURE COEFFICIENT	0.02dBm $^{\circ}C^{-1}$
INPUT IMPEDANCE	10MΩ shunted by 200pf
INPUT TYPE	Floating, 500V max. with respect to supply earth

RESISTANCE

ACCURACY

RANGE (fs)	RESOLUTION	ACCURACY 1 YR @ 23°C ± 5°C	TESTCURRENT	VOLTAGE @ fs
199.99 Ω	10m Ω	±(0.05%rdg + 0.05%fs)	1mA	200mV
1.9999k Ω	100m Ω	±(0.05%rdg + 0.02%fs)	1mA	2V
19.999k Ω	1 Ω	±(0.05%rdg + 0.02%fs)	0.1mA	2V
199.99k Ω	10 Ω	±(0.05%rdg + 0.05%fs)	10 µA	2V
1.9999M Ω	100 Ω	±(0.05%rdg + 0.05%fs)	1 µA	2V
19.999M Ω	1k Ω	±(0.15%rdg + 0.1 %fs)	0.1 µA	2V

RANGING	Automatic or manual HOLD-UP-DOWN
INPUT PROTECTION	250V a.c. or 150V d.c. for up to 2 minutes
TEMPERATURE COEFFICIENT	(0.01%rdg + 0.001%fs) $^{\circ}C^{-1}$
INPUT TYPE	2 wire configuration

GENERAL

DISPLAY	Red high efficiency seven segment 0.43" LED. Range/decimal point automatically annunciated. Autozero and auto polarity.	
READING RATE	3 readings per second all functions	
OVERRANGE	Reads up to 28500, display flashes to indicate overrange condition 2 not shown	
OPERATING AMBIENT TEMPERATURE RANGE	0 to 40°C	
HUMIDITY	80% RH at 30°C	
POWER REQUIREMENTS	115V or 230V (+10 −6%) by internal tap change 50 or 60 Hz	
DIMENSIONS	Heights 80mm, Depth 230mm, Width 220mm	
WEIGHT	1.5kg approx	
ACCESSORIES SUPPLIED	One pair of crocodile clips	One pair test leads
	One test prod	Instruction book
OPTIONAL ACCESSORIES	Carrying case	High voltage probe
	20A and 200A shunts	Spare test leads
	Deluxe probe kit	Rack mounting kit (single or dual)
	R.F. probe kit	Service manual
	IEEE 488 interface unit for use with b.c.d. version.	Packet of 5 spare fuses for current ranges.

BCD VERSION — Available with opto-isolated b.c.d. outputs and programmable range selection.

OPERATING INSTRUCTIONS

Installation

The DM141 is normally supplied set for use with a.c. mains supplies of nominal 230V, 50Hz. Check that the instrument supplied is suitable for the local mains supply. Units which leave the factory set for nominal 115V. 50Hz inputs bear an additional label on the back panel.

To change from 230V to 115V supply setting:-

1) Ensure that the mains and input leads are disconnected
2) Remove covers as detailed on instrument back panel
3) Unsolder the mains wire that comes from the on/off function switch to the brown transformer wire and reconnect it to the post with the white transformer wire.
4) Mark the unit to indicate 115V operation only.

The three core mains lead should be connected as follows:-

Brown - Mains LIVE
Blue - Mains NEUTRAL
Green/yellow - Earth

Operation

Connect the mains lead of the instrument to the mains supply. The operation of the instrument has been kept as simple as possible, the only controls being the function switch, up/down, manual/autorange buttons, dBm button and the d.c./a.c. mode switch.

CAUTION

When making voltage measurements ensure that the source signal does not include high voltage spikes in excess of 2.5kV peak and always remove input from the multimeter before disconnecting mains.

Measuring d.c. volts

Select 'V' on the function switch, d.c. on the mode switch and either 'auto' on the range switch or select the required voltage range manually. The display should light up.

Connect the two test leads to the appropriately coloured terminals using the short 4mm plugs, attaching a probe and croc. clip to the other ends. On shorting the leads a reading of 000.00mV (+4 digits after 30 minutes warm-up worst case) should appear. Connect the leads to the voltage to be measured and the unit will display that voltage either by selecting the most appropriate of the five ranges for itself or this having been done by the user. E.g. For 2.7451V the unit will automatically select the 19.999 volt range and display 2.745V + the allowed error (resolution of 100μV). Had the user wanted 10μV resolution he would have selected the 1.9999 volts range and the meter reading would be .7451V in an overrange condition, all digits flashing and the 2 being assumed.

In autorange, the unit upranges at a count greater than 19999 giving a reading of 2000 or greater on the next highest range, and downranges at less than 1800 giving a reading less than 18000 on the next lowest range. The reason for the overlap is to prevent annoying range changes for slightly varying readings. A particular range may be selected and then held as indicated earlier, by means of the auto/manual and up/down range select buttons. This would be useful in circumstances where a constant resolution is required such as curve plotting or in nulling applications where a change to greater sensitivity can give the impression that the null point has been traversed.

If the instrument is switched on in the manual ranging position then regardless of the range it was on before being disconnected from the mains, it will always go to the most sensitive range possible vis. mV on the volts function. When a range is held and a count of 19999 is exceeded, the display will flash on and off to indicate overrange. However, the unit will still function up to a count of 28500 but the 2 will not be displayed, see previous example. The d.c. voltage ranges are protected up to 1000V even if the lowest range is held. Voltages in excess of 1000V may cause serious damage to the instrument and should be avoided. Note also that the 'LO' terminal (black) must not be taken more than 500V above earth (case) potential.

Measuring d.c. current

Switch the function switch to whichever of the two current ranges are most appropriate (either 20mA or 2.0A) and select d.c. on the mode switch, then connect the leads in series with the current to be measured using the black and white multimeter terminals. The result will be displayed together with correct positioning of the decimal point.

Protection of the internal shunt (nominally .1 and 10Ω for 2A and 20mA resp) is provided by a 2A 20x5mm fuse located in the right hand side panel (viewed from the front) under the carrying handle. It may be removed by turning the screw about ½ a turn. The fuse and carrier screw will then spring out.

Replacement fuse:- 2A 20 x 5mm super quick acting type only
Manufacturer:- Schurter, part number SA0340904

In order to protect the shunt and associated circuitry, forward conducting diodes are placed so that when the voltage across the shunt reaches 600mV, they conduct the current away, blowing the fuse. For continuous measurement of up to 20A an external shunt is available for use on the d.c. volts range. The DM141 will autorange to 200mV range and to read current in A ÷ 10. To read amps on the 200A shunt, reading is direct.

Measuring resistance

Switch the function switch to Ω. Without a resistance connected to the input leads the instrument ranges up to the highest range (20M) and then flashes to indicate open circuit resistance (above 20M). The actual reading under these conditions will be a flashing number above 8600.

When an unknown resistance is connected across the test leads, the display and units annunciation will indicate its value. Warm up time for best accuracy is 30 minutes.

On the lowest range (200Ω) the test leads and/or connections may yield a small residual resistance. The leads should be shorted together and the residual reading (for example 0.2 Ω) subtracted from any measurements taken on this range.

When measuring high resistance on long leads or with large electromagnetic fields it is possible to encounter a.c. pick-up which may produce an erratic reading. This may be minimised by guarding or screening the unknown resistance and the connecting leads to either the LO terminal or to earth.

The resistance ranges are protected against inadvertent application of voltage to the input terminals. However, since the voltage at the input is dissipated across an internal resistance this may cause excessive heating of the instrument if a high voltage is left connected for more than a few minutes

Diode and semiconductor junction test.

Select the 2kΩ range by means of the manual range select buttons, this gives a maximum volts drop of 2V across the unknown resistor/diode (2V is the measuring voltage on all the ranges except 200Ω which is 200mV).

The black terminal is more positive than the red, so when testing for forward conduction, the anode should be connected to the black terminal. Conduction is indicated by a display in the order of .5 or .6 for silicon junctions. Non conduction i.e. reverse biased or open circuit is indicated by overranging of the display.

Measuring a.c. voltage and current

Follow the same procedure as in d.c. voltage and d.c. current but select 'a.c.' ∿ on the mode switch.

If the a.c. source is high impedance invalid readings may occur due to pick-up from stray electromagnetic fields. Screened input leads to earth or the LO terminal should prevent this. A 4mm to b.n.c. socket adapter, as provided in the optional de-luxe probe kit, is particularly useful for this purpose.

Due to the high input impedance and fast response time it is sometimes possible for 'noisy' reading to occur under conditions of high input voltage and/or low frequencies. This noise is normally 3-4 digits of the least significant digit and the actual reading is the mean of the maximum and minimum readings. Also when measuring 240V mains voltages the neutral should be connected to the 'LO' terminal to reduce any mains cycling effects.

When measuring high voltages at high frequencies (eg 500V at 1kHz) it may be necessary to manually select the top range to stop possible 'lock-out' of the autoranging.

The DM141 measures and reads true r.m.s. of the a.c. input. It will measure a.c. waveforms with a crest factor of up to 5 at 10,000 and 2½ at 19,999 with frequencies up to 20kHz. Allow a 30 minute warm-up period for best accuracy.

Measuring decibels

Select decibels on the front panel rotary switch and a.c. mode on the front panel push button. Two ranges of decibels are available +30 to −20dBms and −20 to −60dBms, after deciding which is most suitable select that range with the 'dBm' pushbutton.

The instrument is calibrated such that 0dBm is defined as 1mW into 600Ω,

$$\text{dBm displayed} = \frac{20 \log (V_2)}{774.6\text{mV}}$$

This is derived from:-
A signal level expressed in dBm is calculated from $20 \log \frac{V_2}{V_1}$ where V_2 is the input voltage and V_1 is the 0dB reference of 774.6mV.

$$0\text{dBm} = 1\text{mW into } 600\Omega$$

$$1 \times 10^{-3} = \frac{V_1}{600}$$

$$V_1 = \sqrt{.6} = .7746\text{V}$$

$$\text{dBm displayed} = 20 \log \frac{(V_2)}{774.6\text{mV}}$$

i.e.	V_2 (input volts)	Multimeter reading
	774.6mV	0
	77.46mV	−20dBm
	7.746mV	−40dBm
	0.7746mV	−60dBm

At very low levels of input combined with high frequencies (20kHz) vis. working at the −20dBm point on the +30 to −20dBm range, errors on the converter become significant, in order to obtain better accuracy, the lowest range (−20 to −60dBm) should be used for this measurement. Please refer to specification for accuracy limits.

CIRCUIT DESCRIPTION

The DM141 features PMOS, low power Shottky and BIFET integrated circuits to provide a sophisticated system of measurement with relatively few devices. The power supply requirements for the i c.s,are 5 volts and ∓12 volts d.c. These voltages are obtained from a transformer mounted on the unit back panel. This supplies power to the 12V regulators on the main circuit board and the 5V regulator on the back panel. The position of the 5V regulator on the back panel is necessary to provide an adequate heatsink for approximately 400mA of current. All other components are fitted on the main board or on the display board which is attached at right angles to the main board. This main assembly is located into the chassis by means of four mounting brackets and the front panel switch nut.

The instrument which is basically a sophisticated panel meter consists of an analogue to digital converter which is automatically set to 200.00mV for the lowest voltage range (the gain of the i.c. is adjusted to accommodate to this voltage) and 2.0000V for all other ranges.

All functions are then represented by voltages either 0-1.9999V or 0-199.99mV and the panel meter displays them with the correct annunciation. A.C. voltage, d.c. voltage and resistance are provided with annunciation by five LEDs. Range and function annunciation on all other ranges is provided by the function switch markings.

The analogue to digital converter consists of a pair of i.c.s, one of which is the analogue processor and the other the digital processor. The principle of operation is the quantised charge accumulation technique whereby two inputs are fed into a summing integrator. One of these inputs is a current proportional to the input voltage, the other is a current proportional to a reference voltage (derived from a temperature compensated zener diode) which is pulse width modulated by the internal control logic. The number of pulses of reference current necessary to balance the current derived from the input voltage is determined and then recorded on a counter. These pulses represent a measurement of the value of the input voltage referred to the zener reference voltage, which can then be presented in terms of volts on the display.

Prior to the measuring cycle described above, an auto-zero cycle is executed which connects the input amplifier to zero volts, any voltage present at the output is therefore an error, the value of which is stored and taken off the next conversion thus automatically compensating for any non-linear or temperature dependent errors. An external clock controls the sampling rate and is arranged to have a whole number of mains periods in one sample thus giving good rejection to mains interference.

The basis of all the autoranging is done with an up/down counter which actuates relays to alter the thin film attenuator and annunciation. At a count of greater than 19999 an encoded overrange signal appears at the output of the digital processor. This is decoded and used by the up/down counter to uprange the function. Similarly at counts of less than 1800 an encoded underrange signal is used by the up/down counter to downrange the function.

The same attenuator and reed relays are used to form and select sensing resistors for a constant current source in the ohms mode. The currents are arranged to give 200mV drop on the 200Ω range and 2 volts on all other ranges.This means that on the 2.0000kΩ range and above,the unit can be used to test semiconductor junctions. In this mode the black is more positive than the red terminal and for forward conduction tests, the black terminal should be connected to the anode of the diode under test.

The a.c. to d.c. converter consists of a monolithic i.c. which embodies an implicit solution of the r.m.s. equation. The actual computation performed follows the equation $Vr.m.s = Avg \frac{(Vin^2)}{Vr.m.s.}$. The transfer function results in

$$Vout = 2R_2\, Irms = Vin\ r.m.s.$$

where R_2 = load resistance

Irms = output current

A dB output is also provided from the i.c. enabling a direct conversion from a.c. volts to dBs. A x10 amplifier is used in the input of the r.m.s. converter such that even when measuring on the 200mV range the i.c. sees 2 volts.

The a.c. input voltage is attenuated and then frequency compensated before being fed into a high impedance buffer amplifier/x10 amplifier (x10 when 200mV range is selected). The autorange circuit is similar to that in the d.c. volts mode except that a FET switch is used to select either x10 or the unity buffer amplifier mode. The x10 amplifier is also used on the lowest dB range vis. −20 to −60dB.

The current ranges utilise a precision made shunt of 0.1 and 10Ω for 2A and 20mA respectively. These ranges are *manually selected* and are protected by 'back to back' diodes and a 'super quick acting fuse'. Maximum current on each range produces 200mV across the particular shunt being used. The resistance of the shunts have been chosen so as to introduce as little change as possible into the circuit under test.

RE CALIBRATION

It should not be necessary to recalibrate the DM141 more than once a year. However if it has been repaired or modified in that time then recalibration might be necessary. Under these circumstances or for the full yearly calibration, the unit should be returned to our Service Dept.
Allowances are made within the specification limits for some changes to occur between yearly recalibrations. These changes will alter its accuracy but still leave the unit well within its specified limits.
If, however, the user wishes either to check that the unit is working properly or readjust the calibration pots. to achieve maximum accuracy then the unit can be quickly calibrated in the following way.
N.B. The d.c. voltage function must always be calibrated prior to recalibration of any of the function(s).

D.C. volts

Equipment required:- D.C. voltage source better than or equal to .001% accurate and covering ranges 0 to 199.99mV
0 to 1.9999mV
0 to 19.999V
0 to 199.99V
0 to 1000V.

After allowing the instrument to warm up for 30 minutes short the red and black input terminals together using a terminal link. With the instrument on the 200.00mV range, adjust P11 to achieve zero. This potentiometer is necessary on the 200mV range to compensate for small thermal currents not compensated for by the autozero loop and not necessary on other ranges because the thermal errors become insignificant.
Set the reference source to 1.9000 volts and adjust P10 until the instrument reads 1.9000 volts. Then set the reference source to 190.00mV and using P9 adjust the reading to 190.00mV. P10 must be set before P9 to avoid interaction between the ranges. The accuracy of all other ranges should now be improved as parameters are ultimately measured in terms of d.c. volts and thus the accuracy of all functions is ultimately determined by the d.c. voltage accuracy.

A.C. volts

Equipment required:- A.C. source 0.1% accuracy between 45Hz to 20kHz and covering ranges 0 to 199.99mV
0 to 1.9999V

After allowing the instrument to warm up for 30 minutes, short the red and black input terminals together using a terminal link. With the instrument on the 2V range adjust P4 to achieve zero.

Set the DM141 to the 2 volts range and connect it to the reference source set to 1.9000 volts 110Hz. Adjust P5 so that the multimeter reads 1.9000 volts.

Select the lowest a.c. range and apply 190.00mV 110Hz from the reference source. Adjust P2 so that the multimeter reads 1.9000 volts.

For a full frequency response calibration, the unit should be returned to our service department.

Ohms

Equipment required:- Resistance box of .01% accuracy and covering ranges

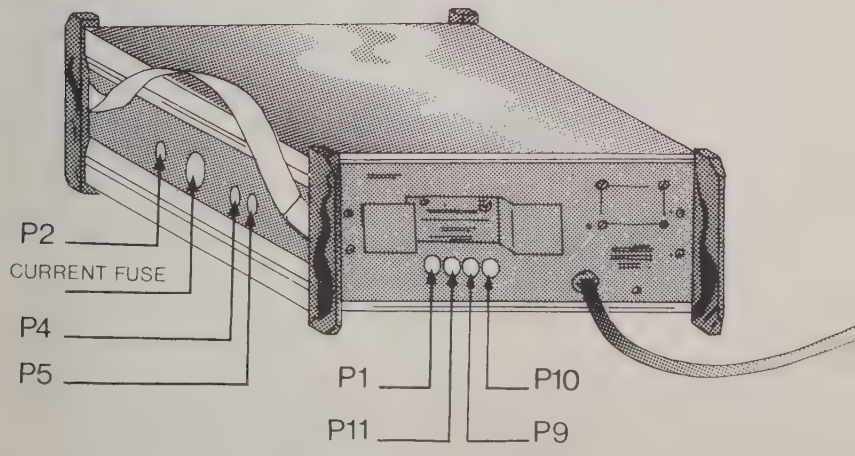
0 to 199.99Ω
0 to 1.9999kΩ
0 to 19.999kΩ
0 to 199.99kΩ
0 to 1.9999mΩ
0 to 19.999mΩ

After allowing the instrument to warm up for 30 minutes, apply 19.000kΩ to the terminals and set the multimeter to read this, with P1 on the backpanel.

Check all ranges at full scale are now within specification

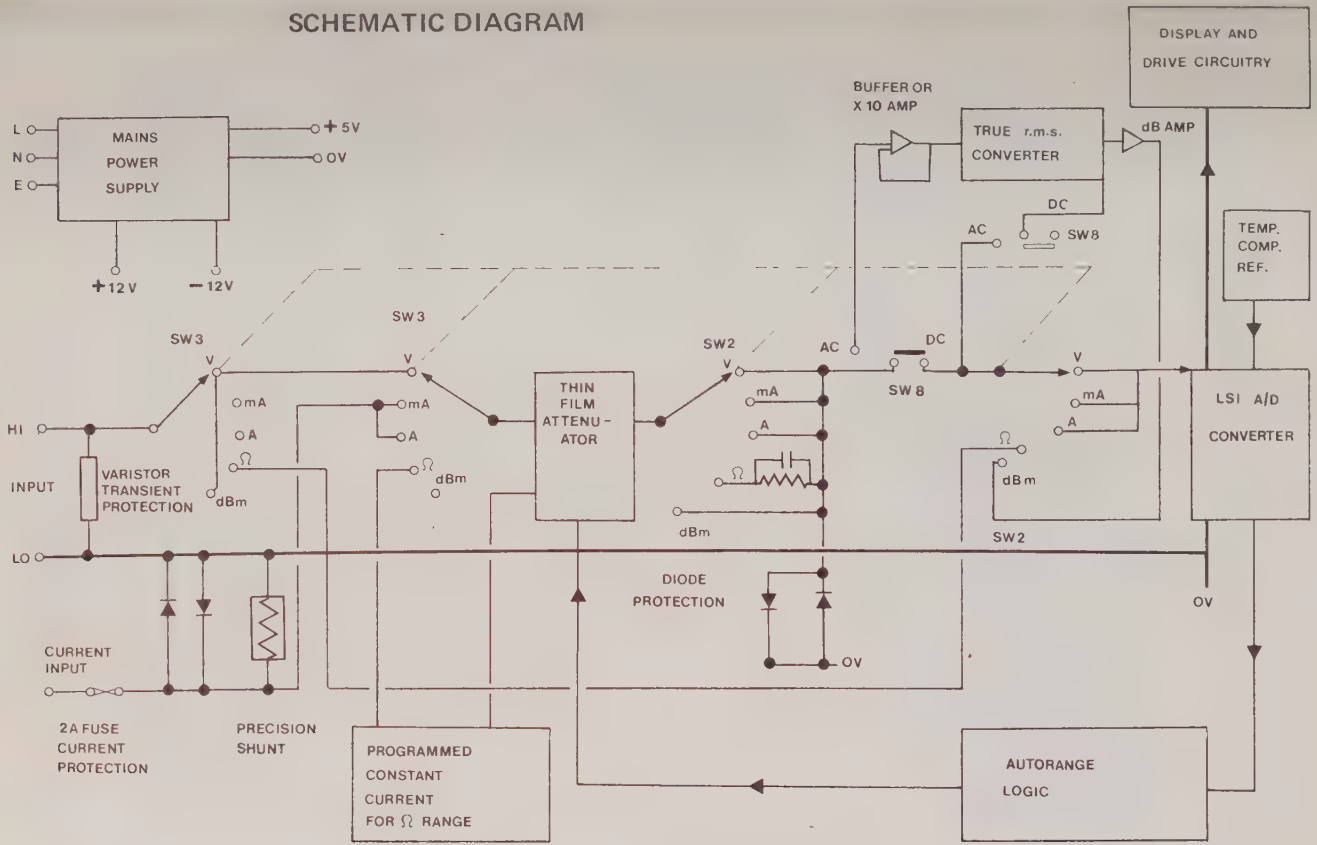
A.C. and d.c. current.

As these functions use a custom made shunt no calibration is necessary.



POSITION OF CALIBRATION POINTS ON FARNELL DM141

SCHEMATIC DIAGRAM



MAINTENANCE

Guarantee

The equipment supplied by Farnell Instruments Ltd. is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of despatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to despatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

Maintenance

In the event of difficulty, or apparent circuit malfunction, it is advisable to telephone or telex the Service Department or your local Sales Engineer or Agent (if overseas) for advice before attempting repairs.

For repairs and re-calibration it is recommended that the complete instrument be returned to:-

The Service Department,
Farnell Instruments Ltd.,
Sandbeck Way,
Wetherby, Yorkshire.
LS22 4DH
Tel: 0937 61961
Telex: 557294 FARIST G

or

Service Depot,
Farnell Instruments Ltd.,
Regional Office (South),
Davenport House, Bowers Way,
Harpenden, Herts. AL5 4HX.
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Telex: 826307 FARINT G

Please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss.

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